LAKE ISLE

Alberta
ENVIRONMENT

90-00245/

Lakes attract people. And people want to know why "their" lake is the way it is — why is it so green in July? Is the water quality really deteriorating? How do our activities affect the lake?

This brochure, one of a series on Alberta's lakes, attempts to answer these questions by presenting findings of water quality studies conducted by the Environmental Assessment Division of Alberta Environment.

As you read through the brochure, you may find that you have questions about the concepts and illustrations. At the end is a section called **Explanation of Lake Characteristics**. Refer to this for further interpretation.

Brochures are available for the following lakes:

Sandy Lake	Pine Lake	Lac la Biche
Lac la Nonne	Garner Lake	Nakamun Lake
Wizard Lake	Skeleton Lake	Lac Ste. Anne
Pigeon Lake	Jackfish Lake	Baptiste Lake
Lake Isle	Island Lake	

June 1989

Lake Isle is a scenic, shallow lake that lies near the headwaters of the Sturgeon River. It is located about 80 km west of the city of Edmonton, and can be seen just north of Highway 16 near the hamlet of Gainford. The lake was named "Lac des Isles" for its many islands, and appears on the Palliser map of 1865.[1] The first development on Lake Isle was at Gainford in 1942. Two summer villages, 15 subdivisions and numerous public and private recreation areas now dot the lakeshore. In 1980 there were 1,038 lots, of which 736 were developed.[2]

Fishing

Lake Isle is quite popular for sport fishing. The weedy shoreline provides excellent habitat for northern pike, and walleye are captured farther out in the lake. The lake also supports yellow perch, burbot, white suckers, spottail shiners, fathead minnows and brook stickleback. Lake Isle was fished commercially before 1948 and once since then, in the winter of 1971/72. Walleye were reported to be very numerous in the 1920s, but their numbers seem to have declined. Fishing success is relatively low for walleye, but it is unclear whether this is a problem of fishing technique or small population size. They have not been stocked in Lake Isle, except for one introduction of eggs in 1953. The lake has had partial fish kills in both summer and winter.[3]

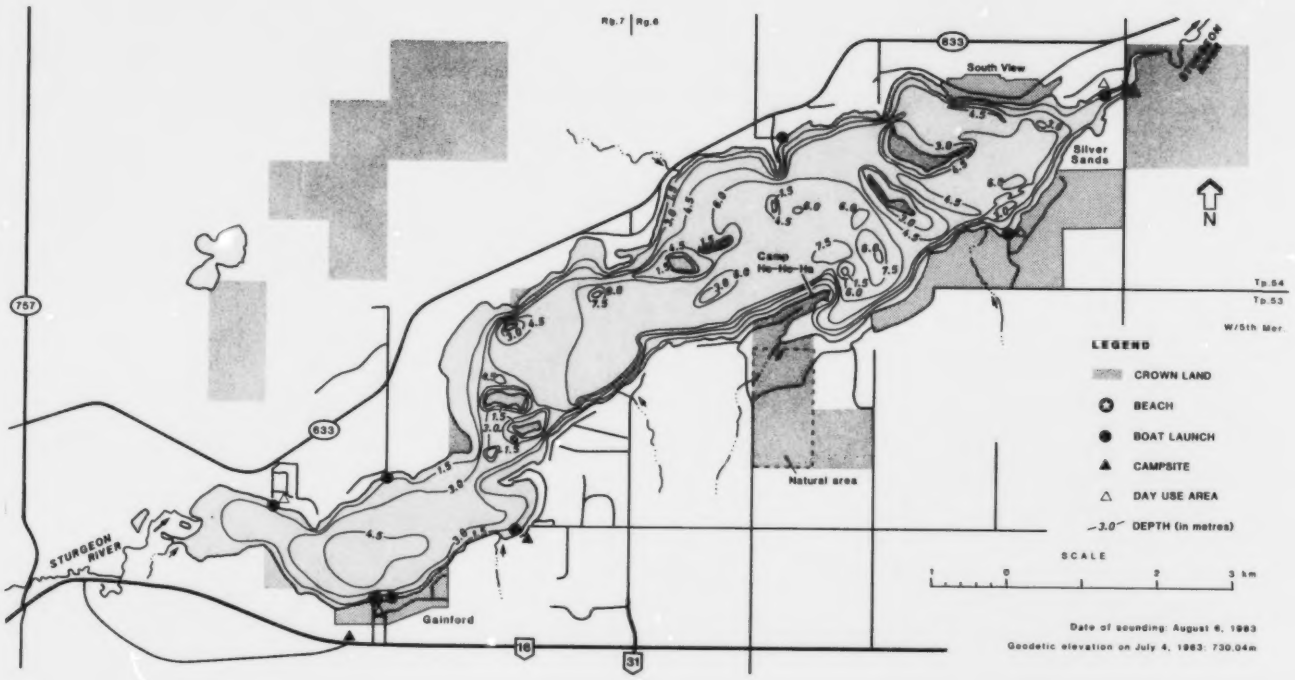
Physical Characteristics

The Depth Contour map shows that Lake Isle is quite shallow; its greatest depth is only 7.5 metres and the average depth is about 4 m. The lake is made up of two basins. The west basin is smaller and shallower than the east.

The water levels of Lake Isle between 1960 and 1987 are shown on the Historical Water Level graph. The level has ranged between a high of 730.72 m in 1965 to a low of 729.22 m in 1968. Over the past 10 years, the water level has fluctuated only about 0.8 m. No control structures have been built to regulate the lake level.

1. Holmgren, E.J. and P.M. Holmgren. 1976. Over 2000 place names of Alberta, 3rd Ed. Western Producer Prairie Books, Saskatoon.
2. Edmonton Regional Planning Commission. 1983. Lake Isle Management Study.
3. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division.

Depth Contours of Lake Isle



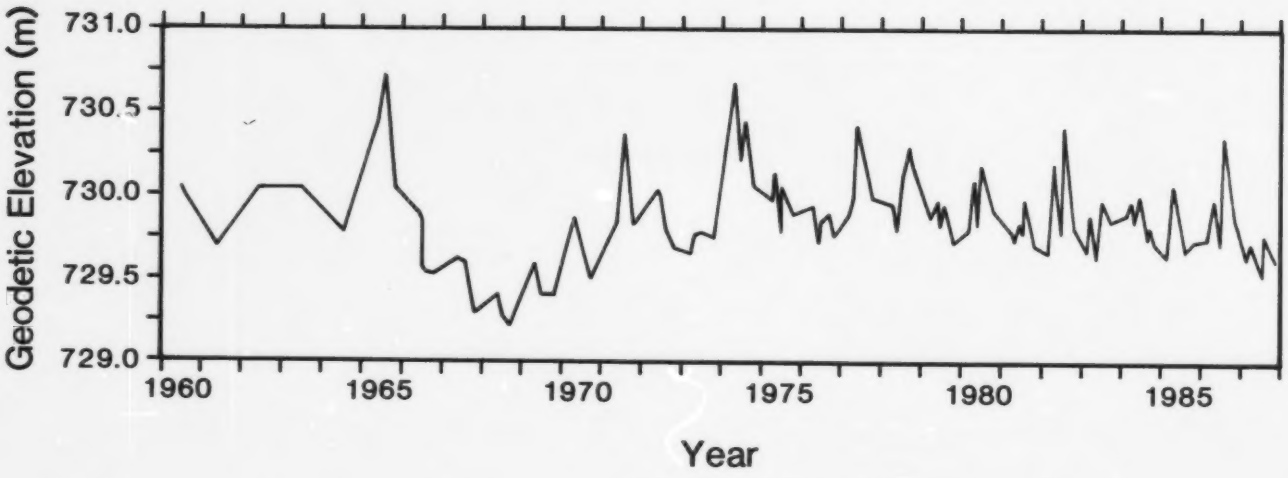
PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

LAKE AREA [a]	km^2	23.0	
DRAINAGE AREA (excluding lake)	km^2	246	
DRAINAGE AREA/ LAKE AREA		10.7	
VOLUME [a]	m^3	94.8	x 10^6
MAXIMUM DEPTH [a]	m	7.5	
MEAN DEPTH [a]	m	4.1	
SHORELINE LENGTH	km	41.1	
TOTAL INFLOW [b]	m^3/yr	24.7	x 10^6
TOTAL EVAPORATION	m^3/yr	14.8	x 10^6
RESIDENCE TIME [b]	years	9.5	

a. on date of surrounding August 1963
b. Excludes groundwater

The watershed of Lake Isle is fairly large compared to the size of the lake (see Watershed map). The main inflow is the Sturgeon River, which flows into Lake Isle through a marshy area at the west end. Several intermittent streams also drain into the lake. The Sturgeon River flows out of Lake Isle at the extreme east end, through Lac Ste. Anne and Big Lake, to join the North Saskatchewan River downstream of Edmonton.

Historical Water Level of Lake Isle



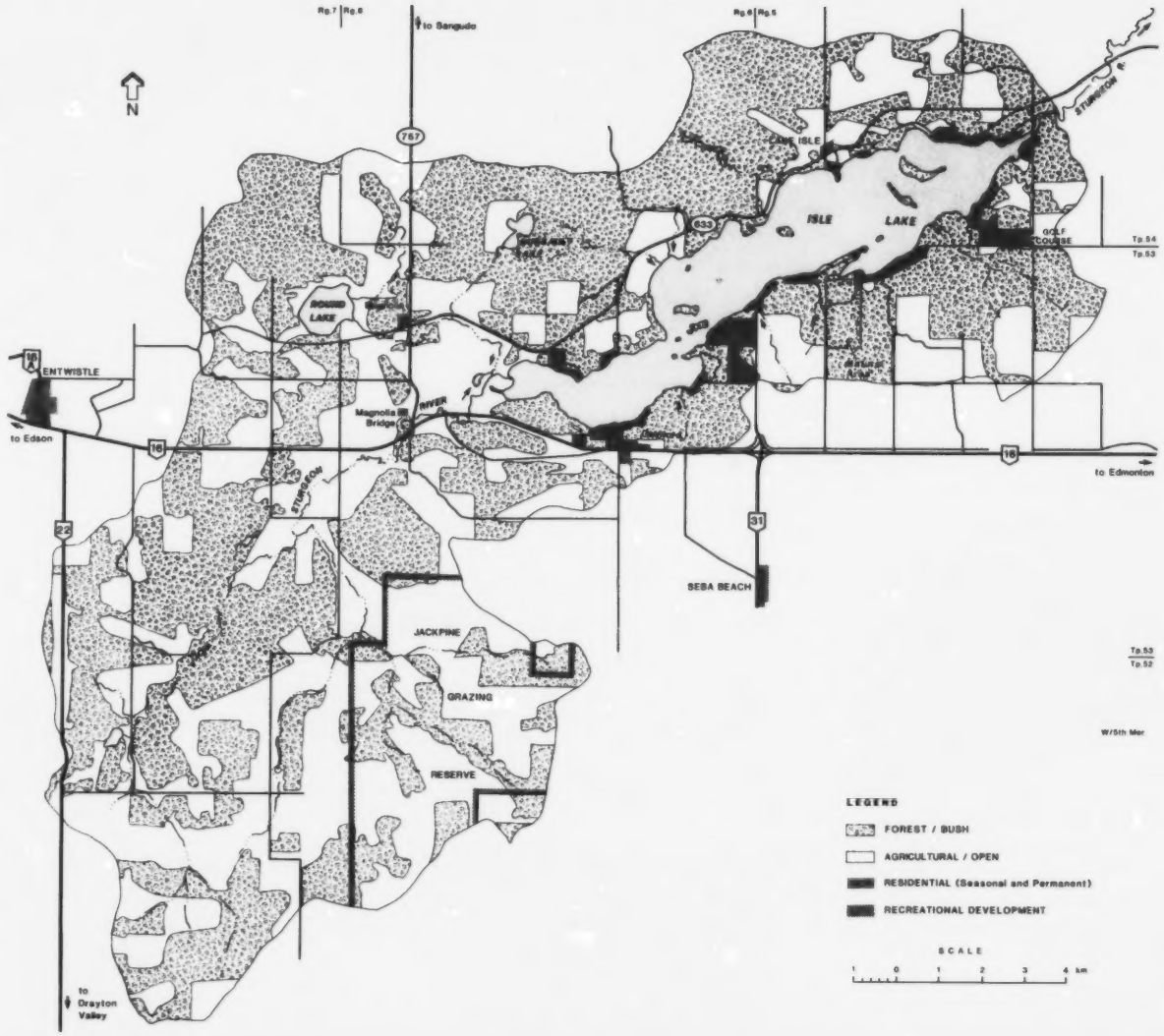
Nutrient Sources

Lake Isle is very rich in plant nutrients such as phosphorus and nitrogen. Phosphorus is particularly important because it is the main determinant of algal growth, and therefore recreational water quality, in most Alberta lakes.

The soils in the watershed are a source of nutrients to Lake Isle. Nutrients are transported in rain or snowmelt water as it flows over the land. Agricultural land, particularly that used for grazing of cattle, provides a large proportion of the total supply from outside of the lake (see the Theoretical External Phosphorus Supply table). As the Watershed map shows, about half of the land surrounding Lake Isle is used for agriculture or is cleared. The quantity of phosphorus that might enter the lake from leaking septic systems around the lakeshore is predicted to be quite small, but this has never been measured on Lake Isle - it was estimated from studies on other lakes. The Areal Loading value in the table provides an estimate of the total amount of phosphorus entering Lake Isle per square metre of lake surface. This value (0.33 g/m^2) is quite high compared to areal loading values for other lakes, suggesting that this lake is very EUTROPHIC, or fertile.

Another important source of nutrients that is not listed in the table is the mud or sediment on the bottom of the lake. In many shallow lakes the sediments are very rich in phosphorus. Under certain conditions in mid-summer, phosphorus moves out of the sediments and mixes into the overlying water. This "fertilization" stimulates algal growth and produces the intense blooms of blue-green algae so common in Lake Isle in summer.

Watershed of Lake Isle



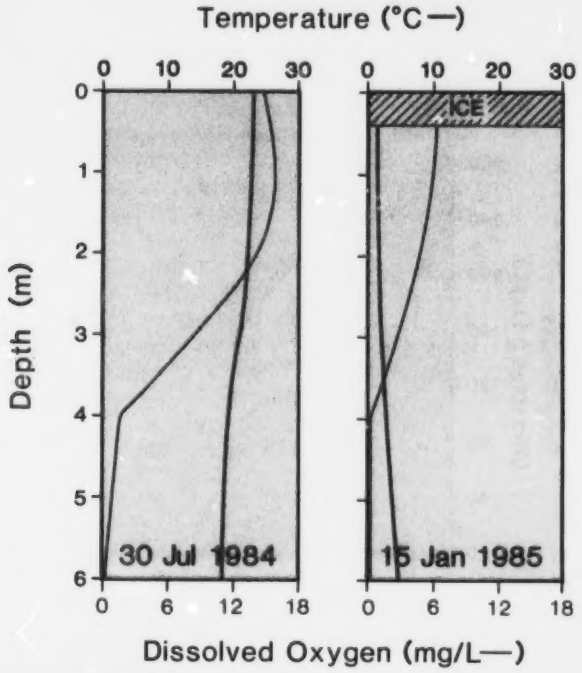
THEORETICAL EXTERNAL PHOSPHORUS SUPPLY

	kg/year	percentage
SURFACE RUNOFF:		
Forested/Bush	1327	17
Cleared/Agricultural	5524	72
Urban/Cottage	273	4
PRECIPITATION, DUSTFALL	498	6
SEWAGE FROM COTTAGES AND CAMPS	51	1
TOTAL	7673	100
AREAL LOADING (g/m^2 of lake surface)	0.33	

Temperature and Dissolved Oxygen

Because Lake Isle is shallow, it mixes from the lake surface to the bottom when it is windy during the summer. But sometimes on a hot, calm day the water at the surface warms rapidly, and then the layer of cool water at the bottom resists mixing (see Explanation of Lake Characteristics). This is shown on the Temperature and Dissolved Oxygen graph for 30 July 1984. The graph also shows that when there is a temperature difference between

Temperature (°C) and Dissolved Oxygen (mg/L) in Lake Isle



the surface and bottom, as in summer, oxygen near the bottom of Lake Isle can decline to very low levels. This happens because the oxygen is used up as plants, animals and bacteria respire. Sometimes after the "collapse" or die-off of a large bloom of algae, the oxygen at the surface drops, and fish may be stressed. Partial summerkills of fish have been reported in Lake Isle.

In winter, ice on the surface of Lake Isle prevents wind from mixing the water. The Temperature and Dissolved Oxygen graph for 15 January 1985 shows that the water at the bottom was slightly warmer than the water at the surface. The level of oxygen in the lake is often lower in winter than in summer because it becomes used up near the bottom.

Chemistry

Lake Isle is a freshwater lake —the quantity of salts (salinity) and total dissolved solids is low. The Ionic Diagram shows that the major ions are bicarbonate (HCO_3) and calcium (Ca). The pH of the water indicates that it is slightly alkaline and is quite suitable for fish and other aquatic life. Many other lakes in Alberta have this type of chemistry.

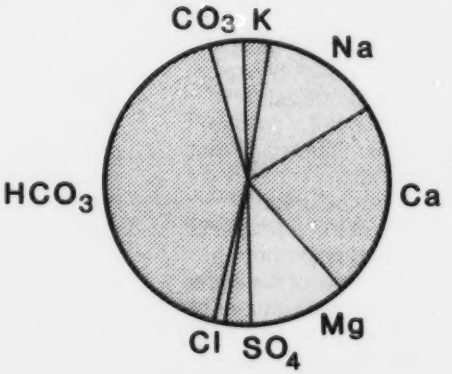
CHEMISTRY Ice-Free Season Averages 1983-1984

CONDUCTIVITY	µS/cm*	284
pH (RANGE)		8.1 - 9.3
ALKALINITY	mg/L**	143
TOTAL DISSOLVED SOLIDS	mg/L	154
NUMBER OF SAMPLES		12

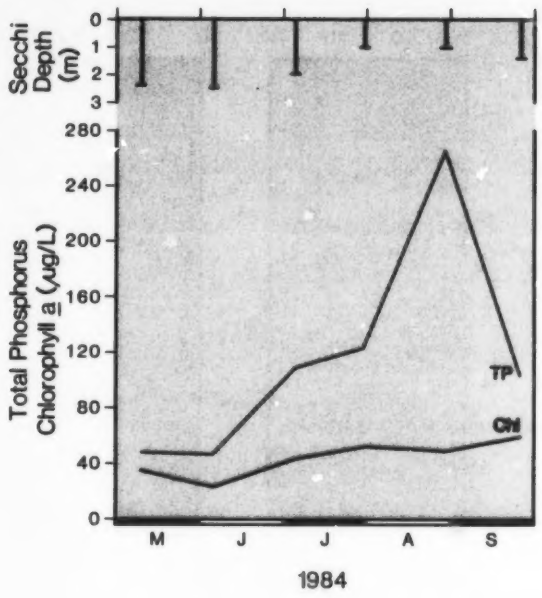
* microsiemens/cm - a measure of the resistance of water and its dissolved salts to electrical flow.

** milligrams per litre = parts per million.

IONIC DIAGRAM Relative Proportions of Ions in Lake Isle 1983 - 1984



Trophic Status of Lake Isle



Algae and Trophic Status

The fertility, or trophic status, of a lake is assessed by measuring the amount of nutrients, especially phosphorus and nitrogen, and the amount of algae (as measured by chlorophyll) in a sample of water. In Lake Isle, the water is green with algae throughout much of the spring, summer and fall. Surface scums and unpleasant odors may occur as these algal "blooms" die and decompose. Average values for monthly water quality samples that were collected from Lake Isle in 1983 and 1984 are reported in the Trophic Characteristics table. These high averages indicate that Lake Isle is very eutrophic. The slightly higher averages for 1984 compared to 1983 are a result of natural year-to-year variation, rather than a sign that the lake is deteriorating.

The Trophic Status graph illustrates changes in the amounts of total phosphorus and chlorophyll a (algae), and in the clarity of the water (Secchi depth) during the summer of 1984. The very sharp peak in phosphorus in late August is likely a result of release from the rich supply stored in the bottom mud or sediments of the lake. Phosphorus from this supply within the lake may be the main cause of Lake Isle's green and turbid condition.

Aquatic vegetation, or the large plants people call "weeds", grows luxuriantly in many areas of Lake Isle. These plants provide excellent habitat for the fish living in the lake.

Lake Isle has always been green and murky. Analysis of core samples collected several metres deep through the bottom mud show that the lake has been very fertile for the past 4,000 years.[4] This fertility is caused mainly by the summer recycling of phosphorus from the bottom sediments, but the large input of nutrients from the watershed probably maintains the lake's eutrophic condition. The increased agricultural use of the watershed, as well as human activities around the lakeshore in recent years, may have increased the nutrient load into Lake Isle. It is difficult to know the effects that this extra load has had on the lake's water quality, because the lake was not sampled fifty or more years ago.

TROPHIC CHARACTERISTICS May - October Average Values

		1983	1984
PHOSPHORUS	µg/L*	93	109
NITROGEN	µg/L	1406	1400
CHLOROPHYLL	µg/L	39	39
SECCHI TRANSPARENCY	m	2.1	1.8
NUMBER OF SAMPLES		7	7

* micrograms per litre = parts per billion = one millionth of a gram in a litre of water.

4. Klarer, D.M. and M. Hickman. 1977. A paleolimnological study of Lake Isle, Alberta. Prepared for Alberta Environment, Pollution Control Division, Water Quality Control Branch.

Explanation of Lake Characteristics

PHYSICAL AND HYDROLOGICAL CHARACTERISTICS

Drainage Area or the watershed of a lake is the land surface from which a lake receives its water. As rain water or snowmelt gathers in streams, it picks up soil particles, nutrients and other materials and carries them to the lake.

A study of more than 30 Alberta lakes shows that when drainage areas are large compared to lake areas, (i.e. when the **Drainage Area/Lake Area** ratio is large), lakes have more algae (are more eutrophic) (see TROPHIC CHARACTERISTICS).

Mean Depth is the volume of the lake divided by the surface area. Shallow lakes are often more eutrophic than deeper lakes of a similar surface area.

Inflow is the total volume of water entering the lake in a year. It is related to **Residence Time**, which is the time it would take the inflow to completely fill the empty lake basin.

The **Geodetic Elevation** on the water level graph indicates the level or elevation of the lake above mean sea level.

TEMPERATURE

Alberta lakes show two basic annual patterns of temperature distribution through the water.

Deep lakes, or those protected from strong winds, form layers with the coldest water near the bottom in summer. Because this colder water is denser, it resists mixing into the warmer, lighter, upper layer.

For much of the summer, the bottom portion of water is isolated from the top portion. In spring and fall, these lakes usually mix from top to bottom by wind action as the water becomes uniform in temperature and density. In winter, under ice, the warmest water (about 4°C) is on the bottom, because water is most dense at this temperature.

Shallow lakes mix throughout the summer or layer only temporarily. In winter, the temperature pattern of these lakes is similar to that of deep lakes.

DISSOLVED OXYGEN

Oxygen is essential to the life in lakes. Oxygen from the air dissolves readily in water, especially on windy days when waves break up the lake surface. The photosynthesis of small aquatic plants also supplies a large amount of oxygen to the lake water.

Oxygen is consumed by respiration of animals and plants, and by the decomposition of dead organisms by bacteria. A great deal can be learned about the "health" of a lake by studying its patterns and quantity of oxygen.

Lakes that are unproductive (oligotrophic) will have sufficient oxygen throughout the year at all depths. But as a lake becomes more eutrophic, and increasing quantities of plants and animals respire and decay, the balance shifts towards consumption — especially near the lake bottom where dead organisms accumulate.

In deep productive lakes (see TEMPERATURE), the oxygen in the isolated bottom layer may deplete rapidly, forcing fish to move into the upper layer (fish are stressed when oxygen falls below about 3 mg/L). Fish kills occur when decomposing or respiring algal populations use up the oxygen. In summer, this usually happens when an algal bloom "collapses" or dies suddenly.

SALINITY AND TOTAL DISSOLVED SOLIDS

Lake water contains a multitude of dissolved substances. These can be seen by allowing a dish of lake water to evaporate. If the water is filtered to remove living organisms and other particles, and then allowed to evaporate, the residue is called **Total Dissolved Solids**.

The ions* that make up most of this residue can be measured individually. The **Ionic Diagram** presents all of the major ions in a lake in proportion to each other. The salinity or saltiness of the water is indicated by its **conductivity**. Water that is low in conductivity (salinity) conducts electricity poorly.

Salinity is controlled by the types of rock or soil in the watershed and by the amount of evaporation relative to precipitation. Lakes of high salinity, such as many of those found in southeastern Alberta, have fewer species of plants and animals than freshwater lakes; many are too saline to support fish.

* Ions: Chemical form in water of constituents such as sodium and carbonate.

pH AND ALKALINITY

The **pH** of lake water refers to its concentration of hydrogen ions on a scale that runs from 0 (extremely acidic) to 14 (extremely alkaline). A pH of 7 is neutral - neither acidic nor alkaline.

Most Alberta lakes fall between pH 6 to 9, with the majority on the alkaline side. **Alkalinity** refers to the capacity of water to neutralize an acid, and is a measure of the alkaline materials present in the water.

Alberta lakes that were formed in sedimentary bedrock have a large capacity to neutralize acids entering them, such as from acid rain.

THEORETICAL PHOSPHORUS SUPPLY

Lake scientists know that for most lakes, the amount of algae in the water is related directly to the amount of phosphorus. This is because phosphorus is usually in shortest supply relative to all the nutrients that lake plants need. When it runs out, the algal population can no longer increase. A larger phosphorus supply usually results in more algae.

Based on studies from all over North America, the quantity of phosphorus contributed by a hectare of forest during runoff is remarkably similar no matter where the lake is located. Similarly, agricultural or cleared land overlying sedimentary bedrock contributes fairly similar quantities of phosphorus per hectare in most lake watersheds. This was confirmed for Alberta by measuring quantities of phosphorus supplied by various land uses in several lake watersheds.

In all studies, the phosphorus supply from cleared or agricultural lake was greater than that from forest, averaging 2 to 5 times more.

The **Theoretical Phosphorus Supply** is estimated by multiplying phosphorus supply factors for each type of land use by the area of that land use, and then summing the products.

Similar factors are used for the supply from precipitation. The supply from sewage is estimated based on a percentage of the total amount that could be generated by cottages and camps on the particular lake.

It might be expected that a large phosphorus supply would produce a eutrophic lake. But the size of the lake is also important. If the total phosphorus supply is divided by the surface area of the lake, the resulting **Areal Loading** figure can be compared with other lakes, and can be used as an indication of trophic status.

TROPHIC CHARACTERISTICS

The word "trophic" literally means nourishment.

Mountain lakes usually are "poorly nourished" or **oligotrophic**. Levels of nutrients such as phosphorus and nitrogen are low, plant life is sparse, and the water is clear. Fish production is low.

On the other end of the scale are well-nourished or fertile lakes called **eutrophic**. In these lakes, aquatic plants, including tiny suspended algae, flourish because the water contains abundant nutrients.

Mesotrophic lakes, those intermediate in fertility, often combine the best features of the other two types.

In some lakes, the nutrient supply is so high that plant growth inhibits certain recreational uses of the lake. Lake users may consider such a lake to have poor water quality. One of the purposes in studying lakes is to determine whether fertility is increasing.

There are several ways to measure a lake's fertility or **Trophic Status**.

Phosphorus and **nitrogen** can be measured directly. Phosphorus in lakes of the Boreal Forest/Parkland areas of Alberta ranges between 10 and 200 micrograms per litre* (μg/L) (oligotrophic to highly eutrophic), and nitrogen ranges between 500 and 3500 μg/L.

Transparency of the water declines as a lake becomes more fertile. It is measured with a black and white plate called a **Secchi Disk**, which is lowered through the water on a line marked at metre intervals. The depth at which it can no longer be seen is the **Secchi Transparency**.

The quantity of algae in the water can be determined by measuring its content of **Chlorophyll a**, the green photosynthetic pigment.

* equivalent to parts per billion

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